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NATIONAL AGRICULTURAL LIBRARY

ORAL HISTORY INTERVIEW OF
DR. EDWARD F. KNIPLING

CONDUCTED BY

PAUL T. STANFORD

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TAPE TRANSCRIPTION

P R O C E E D I N G S

MR. STANFORD: Today is January 21, 2000. We're at the home of Dr. Edward F. Knipling, in Arlington, Virginia. My name is Tommy Stanford, and we're here today to conduct an oral history interview for the special collection at the National Agricultural Library on the Screwworm Eradication Program.

The screwworm is a pest that's been eradicated using the Sterile Insect Technique developed by Dr. Knipling, and it's been eradicated from the United States, Mexico, and Central America, and the program, to this day, is ongoing in Central America.

Dr. Edward F. Knipling, we're happy to be here in your home today and thank you for participating in this oral history of the screwworm program. If you could start, please, by telling us when and where you were born and a little bit about your early life?

DR. KNIPLING: I was born in Port Lavaca, Texas, March 20, 1909. Port Lavaca is in the southern part of the state on the Gulf -- near the Gulf of Mexico. I was born on a farm. We had a farm of 150 acres. Cotton was the principle crop but we had corn and, of course, some other feeds for the hogs and for chickens and horses, and so on.

But cotton was the major crop. And we had a large

1 family and we did all of the taking care of the crops, members of
2 the family. My father and mother, and there were ten children in
3 the family.

4 Well, in those days, farming was a very difficult
5 occupation. People today, young people today, have no idea what
6 farming was like back 75 or even 50 years ago compared with
7 today. Everything, all the power was with horses and mules. No
8 tractors, no power tools, or no electricity or anything of that
9 nature.

10 MR. STANFORD: I guess that 150 acres was quite a large
11 farm?

12 DR. KNIPLING: What?

13 MR. STANFORD: In those days, that size, 150 acres --

14 DR. KNIPLING: Yes, 150 acres, I think, was a little
15 bit above average. But about 50 acres of the 150 acres was
16 planted to cotton and perhaps 20 acres and so on in corn and in
17 garden and in other crops. And the rest of it was for grazing
18 for cattle, dairy cattle, almost all together. Although each
19 year there were some cattle, some of the calves and so on were
20 grown and marketed, if we could.

21 We also had up to four or five hogs that we slaughtered
22 every year during the winter for meat and, of course, had
23 chickens and dairy cows to milk. We produced nearly all of our

1 food back in those days.

2 MR. STANFORD: And how did that experience growing up
3 on the farm influence your -- did it influence your interest
4 later in life in your education?

5 DR. KNIPLING: On the farm -- of course, just by
6 nature, I was interested in, you might say, animals and plants,
7 but animals, in particular. I was interested in hunting and
8 fishing and whenever I had the opportunity to do that -- and
9 interested in nearly all wildlife, including insects, not only
10 because of their pest nature like the houseflies back in those
11 days. You can't imagine how many houseflies there were around a
12 farm where you had livestock and poultry.

13 We didn't have any way to control flies like that.
14 People just tolerated them, that's all. But there were other
15 insect problems. In growing cotton, the boll weevil was a major
16 pest back in those days. There were years in which our cotton
17 yield was reduced by more than one half or maybe three-fourths
18 because of the boll weevil. In some years, they were less
19 destructive and perhaps the loss wasn't more than 10 percent or
20 something like that. But it was tremendous loss.

21 But the boll weevil was not the only pest we had. As
22 you can well imagine, we had leaf worms on cotton, we had insects
23 infecting the corn and tomatoes. And every plant that we grew,

1 there was some type of insect that was causing damage.

2 And we didn't have much in the way of ways to control
3 insects in those days. About the only thing that we could use
4 was (inaudible), like Paris Green (phonetic) or so on. They were
5 used for insects that it would work on but it didn't work very
6 well on many others. But there were other insects, insects
7 infecting the cattle. There were ticks, I can remember. This
8 was before the tick eradication program was undertaken and I can
9 still remember seeing ticks on some of our cows, you know, half
10 an inch in diameter, big ticks.

11 And one of the more severe pests was the screwworm.
12 The screwworm would get into the naval of calves when they were
13 born or in pigs, or if there was any wounds on the animals. So
14 they were constantly having to look for and treat animals for
15 screwworms when they occurred. And that was a very unpleasant
16 task. You can imagine getting in a hog pen with a sow that has
17 screwworms and try to handle the sow and treat it for screwworms.

18 MR. STANFORD: I'm sure that was a constant battle.

19 DR. KNIPLING: That was something we had to do from
20 time to time, you know.

21 MR. STANFORD: Could you describe your early education?

22 DR. KNIPLING: The education we had, the only school we
23 had up to the sixth grade was a country school that was about

1 half a mile from where we lived. And there were probably each
2 year maybe up to 25 students from the neighborhood that went to
3 this country school. It's just one big room and one teacher and
4 went through six grades. And one teacher taught all six grades.

5 Going to school, I didn't especially enjoy it but it
6 was something that had to be done. And the only way I could get
7 there was walking. I could walk by way of the road and go about
8 a mile but if I cut across the pasture and so on, it was about a
9 half a mile. So naturally, I went that way.

10 And it wasn't very pleasant sometimes during the winter
11 when we had rain and we had to go and cross kind of a swell that
12 during wet weather had water in it. It's not very pleasant going
13 through water on the way to school every day.

14 MR. STANFORD: After that education, what spurred your
15 desire to continue education after that?

16 DR. KNIPLING: Of course, after I finished the sixth
17 grade at the country school, I had to go to the high school in
18 town, which was about four miles away. For several years, it was
19 necessary to go by horses or buggy, but then later, they had
20 buses that would come and pick up the students and we went by
21 bus.

22 I enjoyed high school although it was quite a task
23 going from this country school, you know, one teacher and it was

1 pretty rough to make that transition from the early grades to the
2 high school grade. Well, all during this entire time, I had the
3 desire, you might say, to try to get a good education and go to
4 college.

5 But in those days, especially for country boys and so
6 on, they didn't have the resources. And of course, for a family
7 of ten children, you might say there wasn't any resources in our
8 family. But anyway, I decided I would like to college if I
9 could. And I decided that I would go to Texas A&M. And I had a
10 hard time deciding what to major in but finally I decided that
11 the Agriculture major was what I was best qualified to prepare
12 for.

13 But I didn't know, to begin with, the first couple of
14 years. You know, you didn't major in anything. You had to
15 select a major after, you know, the last two years. And I had
16 the problem of trying to decide what field of Agriculture I
17 wanted to major in. Well, I considered all of them. I
18 considered Animal Husbandry, Dairy Husbandry, Poultry Husbandry,
19 Crops or what have you. But I finally decided that I would major
20 in Entomology.

21 MR. STANFORD: How did you come to that decision?

22 DR. KNIPLING: What?

23 MR. STANFORD: How did you come to that decision?

1 DR. KNIPLING: Well, it was in taking these various
2 courses, you know. You took courses in all these basic courses
3 in Agriculture. But it seemed when I took Entomology, it was
4 something that was more interesting to me and the others, for
5 some reason, I felt like I was a little more qualified in
6 Entomology.

7 Of course, in those days, to begin with, I didn't
8 realize until I was in college that a person might make a living
9 by becoming an Entomologist.

10 MR. STANFORD: So we were talking about -- were there
11 professors at the University that had some influence on your
12 choice of Entomology?

13 DR. KNIPLING: They sure did.

14 MR. STANFORD: Who were some of those people?

15 DR. KNIPLING: I was -- of course, in taking these
16 courses, one of the -- well, a couple of them, actually. A
17 couple of professors in the Department of Entomology impressed me
18 a great deal as they lectured. And I began to really appreciate
19 how important insects were to the welfare of humanity.

20 I didn't realize until that time that such diseases as
21 Typhus and Malaria and what not caused the death of hundreds of
22 millions of people worldwide. Of course, I could observe what
23 damage insects could do to plants and to animals, but to realize

1 from a broad perspective just how important insects were to the
2 welfare of humanity impressed me very much.

3 And I was interested in the details and the biology of
4 the boll weevil or the corn earworm or tomato worm or ticks, or
5 what have you. So it was stimulating, actually, the things that
6 I learned in taking these basic courses.

7 And then when I realized that there was perhaps an
8 opportunity to make a profession out of Entomology, I decided I
9 would major in that field.

10 MR. STANFORD: And tell us something about your
11 employment history. Did you have jobs when you were in school,
12 going to college, or other jobs before you first became employed
13 by the Department of Agriculture?

14 DR. KNIPLING: Well, no, the only jobs I ever had
15 before I went to college was if we had taken care of our crops
16 and so on, I would maybe work for the neighbors or what not in
17 making hay or picking cotton or whatever it be. And of course,
18 if I made a dollar a day, that was pretty good income, those
19 days.

20 At college, I made a deal with my father that if he
21 would help my way through college, I would pay him for half of
22 what it took to get me through college. None of the other
23 members of the family had gone to college up at that time but

1 that was the understanding I had with my father.

2 And I tried to meet the expenses at college as best I
3 could. I got a job as a waiter and this helped tremendously in
4 meeting the costs of tuition and so on. And I also did odd jobs
5 occasionally like mowing people's lawns and so on.

6 But to make a rather long story short, the four years
7 that I went to Texas A&M College, University now, I had spent
8 \$1,800, \$1,800 for four years. And of course, I didn't get any
9 jobs during the summer. I came back and helped my dad on the
10 farm each summer. And cutting or picking cotton or whatever was
11 required to be done.

12 But I did do as much work in college as I could, odd
13 jobs to help pay for it. But then when I did get a job, the
14 first thing I did is I started paying dad back for the money he
15 had loaned me. And although according to the agreement, it was
16 \$900, but I gave him \$1,000.

17 MR. STANFORD: Paid some interest back.

18 DR. KNIPLING: It took me about two years to save that
19 much money to do it and the first thing I did after that was
20 bought me a car.

21 MR. STANFORD: And was that after you started working
22 for the Department of Agriculture?

23 DR. KNIPLING: Yes, that's right.

1 MR. STANFORD: Where did you first start with the U.S.
2 Department of Agriculture?

3 DR. KNIPLING: The first job I had was with the USDA,
4 was a summer job. It was in the summer of 1930. And I might say
5 that before that, I had taken an examination for employment as an
6 Entomologist with the U.S. Government. And I passed the exam and
7 became eligible.

8 But in 1930, I was offered a temporary job with the
9 USDA as a field aide for research on the pink boll worm that was
10 being undertaken down in Mexico by the USDA. So that was the
11 first employment I had as a professional Entomologist. It was
12 only a three-month appointment.

13 But in the meantime, I had applied for and was awarded
14 a scholarship for continuing research at Iowa State University.
15 It was a \$600-a-year scholarship which would permit me to go
16 ahead with an advanced degree. But that time, in 1930 and '31,
17 you know, the Depression was getting pretty bad or beginning and
18 the jobs were, to the disappointment of many college students,
19 actually, there were not many jobs available.

20 So in a way, this scholarship was a job, in a way. And
21 it continued my education. So anyway, that's the way I got --
22 after college, I went on with an advanced degree.

23 MR. STANFORD: Was the work you did with that first

1 temporary job, were you physically in Mexico working?

2 DR. KNIPLING: Yes. Well, it was revealing to me, of
3 course.

4 MR. STANFORD: What part of Mexico was that work done?

5 DR. KNIPLING: It was in kind of north -- the Northern
6 Mexico. I think the State of --

7 MR. STANFORD: Torreon?

8 DR. KNIPLING: Torreon --

9 MR. STANFORD: Or Nuevo Leon or Tamaulipas?

10 MR. STANFORD: (Inaudible) was the name of the town
11 where I went. It was a farming community, irrigated farming
12 community. And they had a serious problem growing cotton,
13 serious pink boll worm and a serious problem. So the USDA had a
14 research station there and I was made -- appointed as a summer
15 aide for research.

16 MR. STANFORD: When did you first become interested in
17 the screwworm problem, working on screwworms?

18 DR. KNIPLING: Of course, as I believe I said earlier,
19 I knew what the screwworm could do to animals and after I had
20 taken this exam and became qualified for an appointment as a
21 junior Entomologist, and after I had gone to Iowa State for a
22 year, there was a job opportunity for me. At first, it was
23 offered for me to take a job as a junior Entomologist, that's

1 equivalent to a GS-5 in those days, in California, to work on
2 household storage products insects.

3 But while at the University, I had met Dr. E.W. Laake,
4 who was on leave to take work, and he was with the USDA. And he
5 was in charge of some work that was being done on the screwworm
6 in Texas. So he requested that they needed an employee there, so
7 he requested that I be given an appointment to work at his
8 laboratory that he was directing at Menard, Texas.

9 And they agreed to do that and they were working on the
10 screwworm, and I was delighted to have the opportunity for a job
11 to work on this problem. So the first job I had, a formal
12 appointment job as a permanent employee with the USDA was an
13 Entomologist working on the screwworm. That was the Bureau of
14 Entomology and Plant Quarantine, at that time.

15 MR. STANFORD: And what type of work were they doing at
16 that time when you started there?

17 DR. KNIPLING: We had there at that time was a kind of
18 a survey, we were operating traps, fly traps, to determine how
19 many screwworms were -- what the population trend of the
20 screwworm was. And that was my main job is to go around and
21 collect the flies from traps at about a dozen locations during
22 the summer and then come back and identify the screwworms that
23 had been captured in -- screwworm flies that had been captured in

1 the traps. So that was the beginning.

2 MR. STANFORD: And how large of a staff was working
3 with Dr. Laake?

4 DR. KNIPLING: Well, they were just the individual who
5 was in charge of the laboratory sub-station, Mr. Parish. There
6 was just myself -- and Mr. Parish and myself were the only two
7 professional Entomologists. There were one or two aides,
8 employees, besides us. It was just a very small station.

9 MR. STANFORD: When did you first conceive the idea of
10 the sterile insect technique?

11 DR. KNIPLING: After the first job working on the
12 screwworm, I was then -- the screwworm had become a problem that
13 had become established in the Southeastern part of the United
14 States, in Florida, Georgia, and that area. For many years, it
15 had not been established in that part of the country but when
16 that happened, it of course, created a lot of problems to the
17 livestock producers. And we set up a research station at
18 Valdosta, Georgia, with a staff of about a half a dozen people.

19 And I was transferred there to work on the screwworm in
20 the Southeastern portion of the United States. And then after
21 about -- this was in 1935, after that, I went back to work on the
22 screwworm at Menard, Texas, where the main job was to develop
23 treatments for wounds of animals to kill worms when the animals

1 became infested and to try to repel the flies so they would not
2 re-invade the infestation.

3 That was my job, working on these screwworm repellents,
4 you might say. Well, at Menard, Texas, there was a staff. There
5 was Dr. Roy Melvin was in charge, and Mr. Parish, and Dr. Raymond
6 C. Bushland, and myself. There were four Entomologists that were
7 stationed at Menard, Texas, working on the screwworm.

8 Well, my job there was to try to help develop screwworm
9 treatments, smears we called them, for controlling the screwworm.

10 But I kept thinking, I said, "What we really need is some way to
11 control the screwworms before they attack the animals rather than
12 just wait until after the animals had the screwworm and then try
13 to control it." I realized that you would never, never really
14 control the screwworm that way. What we needed was some
15 preventive measure.

16 But how to control the screwworm on hundreds of
17 thousands of square miles of territory, of course, seemed like a
18 tremendous undertaking. And the use of insecticides or something
19 like that seemed out of the question and it no doubt was. But
20 then I conceived the idea that perhaps we could rear the
21 screwworm and have it some genetic deficiency that it would then
22 release those genetically deficient insects into the population.
23 They would mate with the normal flies and transmit detrimental

1 characteristics.

2 Just how I came to that conclusion, I really have a
3 little difficulty, even today. But there's one thing that we did
4 know that the actual number of screwworm flies in the population
5 was relatively low and especially during the winter months when
6 the cold temperature would reduce the number and also the cold
7 weather would push the screwworm southward and the over-wintering
8 area of the screwworm was relatively a small area in the United
9 States.

10 Of course, it over-wintered in Mexico and then it would
11 drift back each year. But we knew that the population was low
12 and that it was restricted in numbers. But a very significant
13 development was that Dr. Roy Melvin and Dr. Bushland, two of the
14 people on the staff, had developed ways to rear the screwworm on
15 artificial media.

16 Now, that was a very important -- one of the factors
17 that gave rise to this idea that I had. I figured, well, maybe
18 we could rear these screwworms in large numbers at reasonable
19 cost and actually overwhelm the natural population. Of course, I
20 had no way of knowing just how many screwworms there were in
21 natural populations and I did a lot of theoretical work trying to
22 make some sort of a general estimate.

23 And although I didn't know how accurate the estimates

1 were but it seemed to me that the population during the winter
2 months was probably very low. I mean, maybe not more than 25 or
3 50 flies per square mile, you know, during a given time, and
4 trying to estimate how much it might cost eventually to release
5 maybe 100 flies per square mile per week or so.

6 It all was rather vague but, nevertheless, it seemed
7 that these were possibilities.

8 MR. STANFORD: Was the mass rearing work that Dr.
9 Bushland and Melvin did, was that as a result of some of your
10 ideas and theories on control?

11 DR. KNIPLING: They did this rearing -- developed
12 rearing procedures for research purposes, being able to raise and
13 produce the screwworm for --

14 MR. STANFORD: For supply?

15 DR. KNIPLING: There was no intent on their part, I
16 think, to mass produce the screwworms at that time. But that
17 came after, you know, we conceived the idea that maybe we could
18 have this genetic approach to dealing with the screwworm problem.

19 MR. STANFORD: So their mass rearing work was done
20 essentially to have a supply of these things to work with?

21 DR. KNIPLING: Oh, yeah, it was done later, after.
22 Years later, actually. It was just an idea back in 1937 and I
23 discussed it especially with Dr. Bushland. And we discussed the

1 possibility of genetic deficiencies but also the idea of
2 sterilizing the flies.

3 And of course, we had no way at that time of knowing
4 how we might sterilize the flies. But it was kind of vague all
5 during those years but, nevertheless, I kept thinking about it
6 and this was one way I could imagine that we could do what I felt
7 we had to do and that's to control it before it attacked the
8 animals.

9 MR. STANFORD: How did you first become aware of the
10 concept of the sterilization? I know that Dr. Mueller, H.J.
11 Mueller --

12 DR. KNIPLING: Yes, that's right. There was a lot that
13 transpired from the original concept until this came into being.
14 I was transferred to work on military problems first at Orlando,
15 Florida, during the war, to work on insecticides and repellents
16 for use for the Armed Forces. All this dealing with the
17 screwworm in the way that I talked about or had conceived, no
18 research had been done on it. It had just been a theory.

19 But then, after the war again and I was -- by that
20 time, I was made director of all the research on insects
21 infecting man and animals. So I was still interested in
22 exploring the possibility of controlling the screwworms by
23 genetic means or by the sterility.

1 Well, Dr. Lindquist, who was made director of insects
2 infesting man and animals, and I had moved up to director of all
3 the Entomology research back in 1948 and '49, and so on. I mean,
4 that came later. But Dr. Lindquist was on the staff. And he had
5 seen in a scientific -- an article in a scientific magazine, an
6 article by Dr. Mueller, a noted Geneticist, in which he found
7 that it was possible to sterilize fruit flies by exposure to x-
8 rays without affecting their normal sexual behavior and
9 competitiveness.

10 And Dr. Lindquist mentioned this to me and I thought,
11 "Well, here's a way that maybe we could sterilize screwworms."
12 So I wrote a letter to Dr. Mueller, outlining the theory I had on
13 how we might be able to manage the screwworm by rearing and then
14 sterilizing a large number of flies and releasing enough in the
15 environment to overwhelm the natural population.

16 And I had done a little theoretical work. I had
17 theoretical models I worked out that if you could release ten
18 times as many sterile flies as occurred in the natural population
19 and if their mating opportunities were equal, that would be if
20 the ratio was 9-to-1, the probability of a wild female mating
21 with a wild male was only 10 percent.

22 In other words, there was a possibility of inhibiting
23 reproduction of the screwworm by 90 percent if we could just

1 overwhelm the natural population by a ratio of, say, 9-to-1, or
2 if it was 4-to-1, it would be 80 percent, and so on.

3 So I had worked out models like that. So I wrote to
4 Dr. Mueller and explained the theory, and he wrote back and he
5 said -- well, I asked the question whether he thought we could
6 sterilize the screwworm flies as he had done with (inaudible).
7 And he expressed the view that that could be done.

8 So with his response, he raised some question about the
9 feasibility of doing it in nature but I thought his response was
10 favorable, positive. So I got in touch with Dr. Bushland, who
11 was, by that time, was made director of the research on insects
12 affecting livestock at our laboratory at Kerrville, Texas, and
13 the screwworm was, of course, one of the main projects again.

14 And Bush knew of the idea that I had and we worked
15 together at Orlando, Florida, on the military unit and every now
16 and then, we would discuss the screwworm problem. But anyway, to
17 make a long story short, I discussed this thing I think by
18 telephone with Bushland and I sent him the copy of the letter
19 from Mueller and suggested that he see whether or not he could
20 see if it would be possible to sterilize the screwworm. Well, by
21 that time, you know, they already had ways of rearing the
22 screwworm.

23 So Dr. Bushland did a wonderful job. We didn't have

1 any x-ray facilities but he arranged with a military unit near
2 San Antonio, which is only about 75 miles from Kerrville, he made
3 arrangements to expose screwworm in different stages, larvae and
4 pupae and adults, to x-rays. And to make a long story short,
5 within about six months, he had found out that he could sterilize
6 these screwworm flies and that they would mate normally.

7 And if he put a certain proportion of males, sterile
8 males with normal males in caged populations, that just like I
9 said before, if you get nine times as many sterile males as you
10 have fertile males and they were competing with females,
11 theoretically, 90 percent would mate with sterile males and 10
12 percent with fertile males.

13 Well, he ran these experiments in cages and this is
14 just about what happened. In other words, these flies that were
15 made sterile by x-rays were competitive.

16 MR. STANFORD: And during this time, you were
17 corresponding and communicating with Dr. Bushland and Dr.
18 Mueller, you were located in Washington?

19 DR. KNIPLING: Washington, yes. I was in Washington at
20 that time, yes.

21 MR. STANFORD: And Dr. Mueller, where was he located?

22 DR. KNIPLING: He was in Indiana at that time, I think.
23 That's where I think he did his work, Indiana University.

1 MR. STANFORD: And I understand he was awarded the
2 Nobel Prize of 1946?

3 DR. KNIPLING: That's right. I don't know what year,
4 but he was awarded the Nobel Prize for his work on genetics and
5 the influence of radiation on genetic materials which could
6 affect people adversely, just like it would affect insects.

7 MR. STANFORD: And that was part of that work that you
8 learned of that started that communication with him?

9 DR. KNIPLING: That was a very important factor in
10 deciding to go ahead with it, to actually do some research.

11 MR. STANFORD: Once you and Dr. Bushland had been
12 through that process and Dr. Bushland had done the irradiation
13 experiments at the Army facility, when was the idea of an
14 eradication program first conceived?

15 DR. KNIPLING: Okay, well, after we demonstrated that
16 these flies would perform in cages, of course, the next thing was
17 would they perform in a natural population.

18 MR. STANFORD: In the field.

19 DR. KNIPLING: Now, it's easy to ask the question but
20 it's very, very difficult to get the answer. Well, we knew that
21 the only way we could determine that, you know, the screwworm fly
22 can fly hundreds of miles, for that matter. We knew that we
23 would have to have a well-isolated population somewhere and then

1 release the reared flies after they had been made sterile and see
2 whether or not they -- what proportion of the normal females they
3 would mate with.

4 Now, the screwworm lays its eggs in masses on wounds of
5 animals. So we set up an experiment on the Island of Sanibel in
6 Florida. It's an island of I think 18 square miles or something
7 like that and it's separated from the mainland by about 2 miles.

8 Now, we knew that was not very good isolation but it's
9 considerable isolation. And it had a screwworm population on the
10 Island of Sanibel.

11 So we initiated a program, Dr. Bushland and a Mr.
12 Baumhover, who was an employee. We decided to try to see if we
13 could see what influence we could have on the natural population
14 and we released sterile flies on the Island of Sanibel. It was
15 small enough to where we could rear enough insects to, we
16 thought, overwhelm the natural population.

17 But everything was new, but it was all set up. And we
18 used goats as animals that had wounds which would attract flies
19 and they would lay their eggs. And we started rearing the
20 screwworm at that time on animals. We wanted natural screwworm
21 flies on animals and they were exposed to radiation and then
22 released on the Island of Sanibel. I forgot just how many, but
23 we probably didn't release more than a couple of hundred

1 sterilized males per week on the island.

2 MR. STANFORD: Where were you rearing those flies and
3 radiating them?

4 DR. KNIPLING: They were reared at that time in
5 Kerrville and sent to Florida. A little later, we set up rearing
6 facilities at Orlando, Florida, for work on Florida and in other
7 places.

8 But to make a long story short on this, we were very
9 pleasantly surprised to know that after releasing these flies for
10 several weeks, up to 90 percent of the egg masses that were
11 deposited on these goats were sterile. Well, that proved without
12 a doubt that we could sterilize and release flies in nature that
13 would compete with the normal males.

14 But to do this on an island of 18 square miles or to
15 try it on a larger scale was a big problem. Now, we could not
16 eradicate on the Island of Sanibel because we kept getting a few
17 egg masses that were fertile and there's no question about it,
18 they were moving in on the island.

19 MR. STANFORD: On the mainland?

20 DR. KNIPLING: So we could not prove that we could
21 eradicate the screwworm population by this method. And of
22 course, scientists don't accept things on the basis of what you
23 might target would work; they want proof. And so do Agricultural

1 executives and farmers and so on. So we knew we had to, if we
2 were going to try to use this method to eradicate the screwworm
3 from Florida, that was the objective -- to eradicate the
4 screwworm from Florida and the Southeastern part of the United
5 States.

6 Well, we were kind of stymied. We didn't know what to
7 do for a year or so. And then I got a letter from a veterinarian
8 on the Island of Curacao. That's in the Netherlands Antilles.
9 He wrote a letter, kind of a routine letter, and wanted to know
10 if we had some recommendations how they might deal with the
11 screwworm problem on this Island of Curacao which had become
12 established on the island. It apparently had come from South
13 America.

14 Well, this letter came in and the first thing I did, I
15 looked to see where Curacao was. I had no idea where it was.
16 And I looked at an atlas we had there and found out that it was a
17 small island separated from South America by at least 50 miles.
18 The island only had 170 square miles.

19 And I thought, "Well, this is just the place that we're
20 looking for."

21 MR. STANFORD: Who was the veterinarian that wrote that
22 letter?

23 DR. KNIPLING: His name was Bitter (phonetic). I

1 forgot his first name, but he was Dr. Bitter. Well, I wrote to
2 Dr. Bitter after that and I discussed it first with Dr. Bishop.
3 He was in charge of research at the Bureau at the time. I
4 discussed it with him, the possibility that we might have a
5 cooperative undertaking with the people in Curacao.

6 And he and the chief agreed. So I wrote to Bitter and
7 I proposed that -- I said that this is what we're working on and
8 we would like to have an opportunity to test the principal
9 against an isolated population. And I thought it seemed to me
10 that your problem on Curacao might give us this opportunity."

11 And I inquired whether he would be interested in running a
12 joint experiment and I made it clear that it was a theory; we had
13 no assurance that it would work. But they would like to try it
14 out. So he agreed for a cooperative undertaking. Of course,
15 there was an agreement that worked out between the USDA and the
16 government officials, Netherlands officials, for such an
17 experiment.

18 And that's the way it got started. That was back,
19 what, about 1949 or '50. I forgot the exact time.

20 MR. STANFORD: Was it easy or was it difficult to get
21 support for that particular project?

22 DR. KNIPLING: Oh, yes. We had to do it with the funds
23 that we had. And of course, that was one of the big obstacles.

1 To try this out, we didn't have enough funds to run it on a large
2 scale. That's the reason having this opportunity on a small
3 island, Curacao, was so important. We could not run the
4 experiment against, say, the population in Florida, for example.

5 Later on, we know now that if we had tried to eradicate
6 the screwworm against an un-isolated population, if we had even
7 tried it on 10,000 square miles, it would not have worked. I
8 mean, we didn't know it then but even if somebody had given us \$1
9 million and said, "Okay, try it out in Florida," and if we had
10 tried it out on 10,000 square miles, it would not have worked.

11 I mean, we may have suppressed it but we couldn't prove
12 eradication.

13 MR. STANFORD: Because of the other wild flies
14 migrating back into the area?

15 DR. KNIPLING: Because of them moving in. So that --
16 Curacao was a critical, it was really critical to the development
17 of this technique. If we hadn't had the opportunity on Curacao,
18 I just wonder if and when we would ever had proof that we could
19 eradicate the screwworm by this technique.

20 But with the knowledge, being able to run it on Curacao
21 with the knowledge that it could be used to eradicate was the
22 impetus that when the livestock people heard about this, they
23 come to us and said, "Well, gosh, let's start an eradication

1 program and get rid of the screwworm from all of Florida and the
2 Southeast."

3 MR. STANFORD: On the program in Curacao, where were
4 you rearing the flies and how were you rearing and irradiating
5 the flies for that program?

6 DR. KNIPLING: By that time, we had our rearing
7 facility in Florida, at Orlando, Florida, and Dr. Baumhover, who
8 was in charge of the field work at Sanibel, was also sent to
9 Curacao as in charge of the experiment there.

10 And so the flies were reared at the rearing facility we
11 had at Orlando and were exposed and irradiating and sterilized
12 and were shipped to Curacao by air and released by airplane on
13 the Island of Curacao. And all of that had to be worked out.
14 And we decided we wanted to release the screwworm at the rate of
15 about 1,000 per square mile per week. And Curacao has an area of
16 about 170 square miles so that meant we had to rear and sterilize
17 about 170,000 screwworm flies per week.

18 Now, that was a major undertaking at that time and the
19 funds we had were limited. No one gave us any special funds to
20 run this experiment. We just had to, with the resources we had
21 available, we had to dig up the money for this.

22 MR. STANFORD: And the Island of Curacao provided some
23 support to the project?

1 DR. KNIPLING: Yes, we had to dig up the money from our
2 own budget. But after they started releasing the flies, oh,
3 there was a lot of preliminary work, but after they started
4 releasing the flies and they used goats, again, that had wounds
5 to collect egg masses.

6 So I don't know, I guess, Baumhover maybe had at least
7 a half a dozen goats on different parts of the island to collect
8 these egg masses. And within a week after flies had begun to be
9 released, he would collect an egg mass that was sterile. And
10 within about 20 days, maybe I think something like 50 percent of
11 the egg masses were sterile. So we knew it was working but
12 whether it would work enough, we weren't sure.

13 The second three weeks would be the next generation.
14 The generation of a screwworm is about three weeks. The second
15 three weeks, I think the sterility went up to maybe 80 percent --
16 80 percent of the egg masses were sterile. And by that time,
17 they began to see a little decline in the number of egg masses.
18 The number had declined and the sterility had gone up.

19 And then by the third week, it got to where they could
20 collect very few egg masses. And all of the egg masses,
21 practically all of them began to be sterile. So within about
22 three generations, which is about 60 days or a little more than
23 that, it seemed that the screwworm had been eradicated from the

1 Island of Curacao. It was a remarkable achievement.

2 Actually, the models I had developed indicated that it
3 would take maybe three generations to accomplish this. And it
4 just happened in a way that it actually happened according to
5 theory, pretty well.

6 MR. STANFORD: And you mentioned that once the
7 livestock producers in Florida became aware of that, they were
8 anxious to --

9 DR. KNIPLING: Oh, yeah. There was one thing, I
10 believe I said -- I think it's significant. We didn't say much
11 about -- we didn't publicize that we were undertaking this
12 experiment on Curacao or anywhere else.

13 You know, it's always been a -- federal activity has
14 always been a target to some people, you know, trying to say that
15 you're wasting money or something like that. And especially
16 since this had to do with the sexual behavior, we knew that if
17 the media got hold of that, they could make quite a deal out of
18 this.

19 You know, here is this idea of controlling an insect by
20 sterilizing the males and releasing them. So we didn't say much
21 about running the experiment for fear that if it didn't work,
22 they could make a good story out of that. Here's this stupid
23 idea trying to control insects this way and the government spent

1 so-and-so-much money to do that.

2 So we were rather cautious about that. But anyway,
3 after the success of the experiment, I think the Entomology
4 Bureau put out a news release as it kind of frequently did for
5 any developments and now seeing the success of this technique.
6 Well, when the livestock people, especially in the Southeast and
7 Florida, saw this and they came to us.

8 In fact, I was down there visiting at Orlando after
9 this some time and Dr. Lindquist was there, also. And I forgot
10 his name now but he was on the livestock commission in Florida.
11 He was a veterinarian. And he had heard about this success on
12 Curacao and he came to us and wanted to know whether we could
13 start an eradication program in Florida.

14 Well, of course, that was the whole object of our work
15 there was to see whether or not we might eventually eradicate the
16 screwworm from the Southeast. But gosh, we were not ready to
17 undertake a program like this from 170,000-square-mile experiment
18 raising screwworms at the rate of 170,000 a week. To try to do
19 this in Florida would require 50 million flies a week for release
20 over the whole state of Florida.

21 So we said, "Well, in theory, we think it would work
22 but we need more time. We need to develop better rearing, mass
23 rearing procedures for the screwworm. We really need to prove

1 that it would work in Florida as it did on Curacao."

2 Well, he was not too enthusiastic about our cautious
3 response to this. In fact, he had made arrangements for us to
4 visit the Governor of the State of Florida. He wanted, of
5 course, he needed the support of the state, you know, to meet any
6 expenses that Florida would be involved in. So he arranged for
7 an airplane and he took Dr. Lindquist and I to Tallahassee to
8 meet with the Governor of the State of Florida. I believe it was
9 Gov. Collins (phonetic) was the name of the governor.

10 Well, we went into his office and this veterinarian, I
11 forgot his name, explained the whole theory. And the Governor
12 asked a few questions and he said, "Well, what would it do? Can
13 you undertake this program and get rid of the screwworm in
14 Florida?" And we both said, "Well, we think it will work but we
15 think we need more research. We need to develop better rearing
16 procedures. We have to demonstrate that it will work in
17 Florida."

18 And the Governor asked me, he said, "Well, how much
19 time will it take for you to get this information, and what will
20 it cost, and so on? And what would you gain by developing the
21 information that you need?" And I said, "Well, we think that if
22 we develop the technology better, it would maybe save as much as
23 a couple of million dollars to run an eradication experiment -- I

1 mean, program."

2 So this, I thought it was quite a pragmatic response.
3 The Governor says, "Well, if the most that you feel that you
4 could develop by undertaking this research was to save the \$2
5 million, when the screwworm is costing our growers as much as \$10
6 million a year, why don't you go ahead and start the program now
7 with what technology you have?"

8 Well, that made a lot of sense to me.

9 MR. STANFORD: So then it did get started?

10 DR. KNIPLING: It made just a lot of common sense. And
11 I've used that in numerous occasions before. You know,
12 Entomologists, I guess like all scientists, they just don't want
13 to try something unless they have all the information they would
14 like to have before they go into it. So frequently, they say,
15 "Well, we need a little more information before we try this out
16 or that."

17 And I've used that example many times. I've said,
18 "Now, what would you gain by doing all this research and how much
19 would it delay? Would you gain enough to be sure and what
20 assurance do you have that if you do this research, it will help
21 you out?" I've used that on many occasions and it's a good,
22 practical question.

23 MR. STANFORD: So then the eradication in the Southeast

1 was undertaken?

2 DR. KNIPLING: With that, after we met, they were
3 advised by these livestock people to start an eradication
4 program. Of course, they had to deal with our officials in
5 Washington and had to deal with the plant -- the APHIS, which is
6 now APHIS, at that time.

7 You know, Agricultural executives are cautious people,
8 especially when it comes to asking for money for budgets. You
9 have to have a good, sound basis for asking, at that time, for
10 millions of dollars. It didn't come easy. It doesn't come easy
11 now but it was harder those days than it is.

12 And you know, I've always thought Agriculture was too
13 cautious in its requests for funds, anyway. The military and
14 National Institutes of Health or NASA or what not, they go in and
15 ask for billions of dollars for research. But Agriculture tends
16 to ask in terms of millions. I mean, Agriculture has just been
17 too conservative all these years in asking for research support.

18 But nevertheless, they did, with the pressure from the
19 livestock people, they eventually agreed. They got Congress'
20 support, got them to agree to appropriate money for this
21 eradication program. The state contributed so much and so did
22 the federal government.

23 MR. STANFORD: And then from that program and it being

1 successful, was it a similar situation that moved the program
2 into the Southwest after they saw the success of it in the
3 Southeast?

4 DR. KNIPLING: Of course, with the success in the
5 Southeast, in Florida, the livestock producers in the Southwest,
6 they just practically demanded -- they said, "Good job, if you
7 got rid of the screwworm in Florida and the Southeast, we want to
8 get rid of the screwworm in Texas, too."

9 Well, of course, we realized that this pressure would
10 come and we had discussed what we might do in Texas and the
11 Southwest. But we realized, that Lindquist, Bushland, Baumhover,
12 and I, we discussed it and we came to the conclusion that there
13 is just no assurance that we could eradicate the screwworm from
14 Texas and keep it out. We knew the screwworm's all the way in --
15 stayed in Mexico the year round.

16 So we conceived that it may be possible to use the same
17 technique and eradicate it from Texas and then keep it out by a
18 continuous sterile barrier between Texas and Mexico so that the
19 screwworm could not re-enter. Well, that was a theory that we
20 advanced and we told the livestock producers and our own people
21 that this might work, that we could not provide assurance that it
22 would work.

23 But they were so determined to have a program there

1 that even though there was no assurance that it would work, they
2 demanded, virtually demanded, a program. And the program funds
3 were appropriated and the program was started in I believe 1962,
4 I believe it is.

5 MR. STANFORD: So then that program began but it was a
6 different situation, a different environment in the Southwest,
7 than it was in the Southeast? Were there different challenges in
8 that program?

9 DR. KNIPLING: Yes. Of course, for one thing, the area
10 was larger. And at times, the screwworm population was higher.
11 But the main problem that we could see was that it was not all
12 isolated. I mean, in the Southeast, we had taken the whole
13 population on, it was isolated.

14 But anyway, that was the reservation. But we thought
15 it might work this way to set up that barrier. And a screwworm
16 rearing facility was constructed in Texas which was twice as
17 large as the one in Florida. The one in Texas had the capacity
18 to rear about 100 million screwworm flies per week whereas the
19 one in Florida had a capacity of 50 million.

20 MR. STANFORD: That's the facility in Mission, Texas?

21 DR. KNIPLING: Yes, the one in --

22 MR. STANFORD: Moore Air Base? Mission?

23 DR. KNIPLING: What's the town in Texas, the screwworm

1 facility?

2 MR. STANFORD: Mission?

3 DR. KNIPLING: Mission, yes. That's where it was. And
4 some old military facilities were renovated to make this rearing
5 facility. Mr. Chet Housman (phonetic), I don't know if you ever
6 knew him or not, but he was the engineer that designed the
7 facilities, both in Florida as well as the one in the Southwest.

8 MR. STANFORD: So then there was one controversy in the
9 Southwest, isn't that right, that's referred to as the
10 reproductive isolation controversy?

11 DR. KNIPLING: It's quite a long story to tell you but
12 I think we probably should do this. When the program was started
13 in Texas, the idea, like I said before, is to try to start the
14 program in the wintertime when the population was at the lowest
15 level and was grossly restricted. And then try to eliminate it
16 so it could not grow.

17 But then if that was successful, we would establish a
18 sterile fly barrier 100 miles wide on the assumption that the fly
19 would not come in from Mexico. Well, the first year, it was very
20 successful, actually. More successful than we almost hoped for.

21 During the winter months, the screwworm was practically reduced,
22 the cases practically reduced to nothing.

23 And the springtime, when they normally increased and

1 spread, the population was held low. But we never got rid of it
2 completely. We would keep getting a few cases, you know, and it
3 was puzzling to everybody. "Where are these coming from? Why
4 didn't it get to zero and stay there?"

5 Well, it was kind of hard for people to believe that
6 the screwworm was flying across this 100-mile barrier. But to
7 me, and Lindquist and others, that was the only explanation, that
8 undoubtedly, we had underestimated the distance that these flies
9 could fly. Now, they didn't all, very many get through, but
10 there was enough that got through where we could not get
11 permanent eradication in Texas.

12 Well, one of the things, some of the opponents to the
13 idea said, "Well, you said you were going to eradicate but you
14 didn't. You can't. You haven't succeeded in eradication." But
15 they overlooked the fact that even though we did not achieve
16 eradication, we did not achieve what we had hoped, we never said
17 we would before. We did not achieve what we had hoped. We at
18 least controlled the screwworm.

19 The screwworm population for the first five or six
20 years after the program was started in Texas and the other
21 Southwest region, the screwworm cases I estimated were reduced by
22 98 percent. Now, that's awful good control even if you're not
23 achieving eradication. But that's awful good control.

1 But then things began to kind of break down. And the
2 control was not as good as it had been. It was kind of
3 deteriorating. Instead of the, say, 98 percent control that I
4 estimated, maybe it would drop down to 95 and then around 90.
5 But that's still good insect control.

6 But then by about, I believe it was in 1972, I think it
7 was, it was an especially mild winter and favorable conditions.
8 And the screwworm just overwhelmed, the screwworm overwhelmed the
9 sterile population that we had. And we had an outbreak in '72
10 that was almost as bad as what the screwworm had been without the
11 control.

12 But I kept saying that under the conditions, if we had
13 not had this program, the screwworm would have been five times as
14 damaging even that year as it was and that although the program
15 was not working the way it had, it was still achieving a lot of
16 control. The screwworm abundance over the years varied from year
17 to year, just like any other. But that would have been one year
18 in which the screwworm outbreak would have been tremendous.

19 MR. STANFORD: So was it that outbreak in '72 that then
20 prompted the move of the program into Mexico?

21 DR. KNIPLING: When that outbreak came, well, then some
22 of the opponents -- and you know, there are always opponents to
23 something like this. I don't know why but there are. There were

1 critics of the program. And even though it was a wonderful
2 program, there were critics. And when this happened, then these
3 guys came out from everywhere.

4 There were experts on screwworms that emerged that had
5 probably never seen a screwworm. And they were saying, "Well,
6 your program is not working. You can't eradicate the screwworm
7 this way. You can't even control it." And some of them said,
8 "The screwworm has developed resistance to your sterility
9 technique, just like they develop resistance to chemicals. This
10 proved that the screwworm has become resistant to your sterility
11 technique."

12 Well, you know, it's difficult to answer some of these
13 problems but those of us that knew the situation pretty well had
14 analyzed what was happening. What was happening was this. The
15 program was so successful that the ranchers started releasing
16 their cowboys that they used to retain to look for their animals
17 and to treat the screwworm cases and so on.

18 They started releasing these employees so that they
19 were not watching the animals. And they were not finding the few
20 cases that did occur. Before, they would find them and treat
21 them and that helped the program. But since they were not doing
22 this, they were losing the control -- I mean, the benefits they
23 got of treating.

1 So that meant that the sterile flies that we released
2 were not as effective as they were before because we did not have
3 the help of the growers to manage their animals properly. They
4 were beginning to perform surgery on animals during the
5 summertime when they normally never would do it when there's
6 flies, and that produced more screwworm cases.

7 And another thing, the deer population had increased
8 tremendously and the screwworm develops in deer just like they do
9 others, especially the young fawns in the naval, and so on. So a
10 number of factors, favorable weather and the lack of -- the
11 breakdown of the man/animal management part of this, the
12 sterility program just was not effective, anymore. I mean, not
13 as effective.

14 Not only that, it also -- because to save money, they
15 had reduced the budget for this thing -- and to save money, in
16 some ways to save money, they started releasing flies by aircraft
17 by wider swaths and flying the airplane higher. In other words,
18 they were not doing a good job with the screwworm flies that we
19 did have.

20 So we had a combination of factors that we know now,
21 but at that time we suspected was one of the explanations of why
22 it was breaking down. But we know now that there was no doubt
23 about it.

1 But then, this is the thing, there was beginning to be
2 pressure put on some, "Oh, you're wasting money. You better just
3 do away with the program, altogether." This was coming from some
4 of our scientists, you know.

5 MR. STANFORD: Within the USDA?

6 DR. KNIPLING: What?

7 MR. STANFORD: Within the USDA?

8 DR. KNIPLING: Not within the USDA.

9 MR. STANFORD: From other universities?

10 DR. KNIPLING: From others. No, there was no
11 opposition within USDA. There was concern but not any
12 opposition. But it got, you know, to where there was pressure
13 put on the USDA to abandon this program. So it got to the point
14 where the USDA had appointed a committee to go around and to make
15 a survey and talk to the ranchers and see what the situation is
16 and decide whether the program should continue or not or whether
17 it should be discontinued.

18 Well, these people went around and they interviewed
19 livestock producers and scientists, and what have you, and their
20 report was when they came back is by no means, do not discontinue
21 this program. Although it's not working as well as it had been,
22 it's still the best thing that they have ever had for the
23 screwworm. And it was a very positive report and it at least

1 kept the program going.

2 But it became obvious to me and some of the others that
3 if we're really going to deal with the screwworm problem then we
4 would have to enlarge the program. It was just not large enough
5 to deal with.

6 MR. STANFORD: The success of the program, of course,
7 now we know how successful it was and has been and continues to
8 be with the eradication in the United States, Mexico being
9 declared free in 1991, when I was a part of the program in Mexico
10 I'm proud to say. And of course, now, down into Central America
11 to where they're releasing sterile flies, as well as Jamaica.

12 What are your thoughts and ideas on the current
13 direction of the program, the screwworm program itself, as well
14 as eradication programs of other pests?

15 DR. KNIPLING: You mean, my thought now?

16 MR. STANFORD: Yes, today?

17 DR. KNIPLING: Well, to be absolutely honest, although
18 we recommended the only way we're going to protect the U.S. from
19 the screwworm is to enlarge the program, frankly, myself, I was
20 skeptical of the possibility of eradicating the screwworm from
21 all of Mexico. My concept is that we could have it large enough
22 where we could protect the United States from the screwworm but
23 the idea of eradicating the screwworm from all of Mexico, I did

1 not -- although I considered it, I did not think that would
2 happen.

3 But fortunately, when they enlarged that program and
4 they went from a production capability of 100 million up to 500
5 million, then we had enough screwworms, they could release enough
6 to overwhelm the population. Where it was critical, they could
7 release enough to expand the release area by at least two-fold.

8 And when they did that, that was getting beyond the
9 capability of the screwworm to re-invade. And gradually then,
10 year by year, it was being pushed south. To me, that was a
11 remarkable achievement and these people that carried that out
12 were gradually pushing it south until they got rid of all the
13 screwworms in Mexico and then they got rid of them country by
14 country. And they are just about through for all of Central
15 America now.

16 But anyway, you asked the question, what lesson can we
17 learn from the screwworm program? Well, to me, it's a remarkable
18 program and I sometimes wonder how it ever materialized in the
19 first place and how they were able to get this program underway.

20 But it confirms something that I am absolutely
21 confident of. And this is that if we're going to deal with major
22 insect pest problems, we're going to have to deal with them from
23 an area-wide standpoint, that we cannot deal with these pest

1 problems by just trying to control them year after year on a
2 farm-by-farm basis.

3 Just like we never would have controlled the screwworm
4 that way, we will never control the boll weevil or the corn
5 earworm or the cabbage looper, you will never control these
6 insects this way. I mean, you will control them but you will not
7 reduce the threat. But there is the possibility that we can do
8 the same thing for dozens of other insects that we have done to
9 the screwworm if we will use the same procedure.

10 And not only not just depend on the sterility
11 technique, but I've worked on this, this has been my major
12 interest ever since the screwworm program is how can we do this
13 to other insects? Now it's been successful against the
14 Mediterranean fruit fly and other tropical fruit flies. It's
15 been used against the pink boll worm and the Japanese used it to
16 eradicate the mellon fly. And all of these have been beneficial.

17 But I maintain that it could be used for more insects
18 if it were just done in the proper way. But I think that the
19 parasite augmentation technique which operates in a similar
20 manner is even more effective than the sterile insect technique.

21 And what I've been trying to do for the last 25 years, or most
22 of this since I've retired, is tried to promote the idea of
23 attacking more of these insect pest problems on an area-wide

1 basis rather than trying to control them on a year-by-year basis.

2 And that's one of the things that I'm most interested in, even
3 today, is to promote this concept.

4 MR. STANFORD: And also with a variety of techniques.

5 DR. KNIPLING: Yes, that's right. And I think the
6 sterility technique has more potential than most people realize
7 and the parasite augmentation technique has never even been
8 considered as a possible area-wide management procedure. It was
9 considered for controlling insects, say, on a farm-by-farm basis
10 just like you use insecticide.

11 But the idea of rearing enough of a certain type of
12 parasite to manage the entire population, just like we do with
13 the sterilization, that apparently had never been even considered
14 by biologists. But I kept thinking and all the theoretical work
15 I've done suggests that it would be far more effective than the
16 sterile insect technique.

17 But not to diminish the importance of the sterility
18 technique, when the two techniques are put together, when you use
19 both of them, then they are better than either one alone. So we
20 got not only the potential of managing many insects on an area-
21 wide basis by the parasite augmentation technique, by rearing and
22 releasing a large number, we've got the potential of using these
23 techniques together and make it even more effective. All of this

1 is something for the future.

2 MR. STANFORD: Well, that's very interesting and very
3 informative, and we really appreciate your candidness and your
4 comments and the history you've given us here.

5 DR. KNIPLING: I think it's an honor to have been asked
6 these questions, and I appreciate the opportunity to do this.

7 MR. STANFORD: Well, it's been a real pleasure for me.
8 Thank you very much.

9 (The interview was concluded.)

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